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THESIS

FACILITY DESIGN VALIDATION
OF THE
INFORMATION SYSTEMS LABORATORY

by

Timothy A. Holland

September 1987

Thesis Advisor: N. F. Schneidewind

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When installing a computer system there are many issues which the Information Systems manager must face. This thesis will identify and discuss some of those issues as they pertain to the installation of the Information Sciences Laboratory in Ingersoll Hall, Naval Postgraduate School. The laboratory will contain three local area networks and a number of specialized workstations. The recommendations made in this thesis are the floor plans showing a possible configuration for the laboratory.

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of the
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by

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ABSTRACT

When installing a computer system there are many issues which the Information Systems manager must face. This thesis will identify and discuss some of those issues as they pertain to the installation of the Information Sciences Laboratory in Ingersoll Hall, Naval Postgraduate School. The laboratory will contain three local area networks and a number of specialized workstations. The recommendations made in this thesis are the floor plans showing a possible configuration for the laboratory.

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I. INTRODUCTION

A. PURPOSE

When installing a computer system there are many issues with which the information systems manager must concern himself. Those issues are the brunt of this thesis. This thesis will identify and discuss the issues that the information systems (IS) manager must face when installing a local area network (LAN), but the issues will pertain to any installation of a computer facility. The author will address three different LAN's which are to be installed at Naval Postgraduate School as the Information Systems Laboratory. These LAN's are the IBM Token Ring, Apple Computer AppleTalk, and 3Com Ethernet. In addition, the IS laboratory will contain a number of highly specialized workstations.

This chapter is an overview and explains what the networks are and what their functions are to be once installed. It also gives a short narrative of the recommendations made by the author. Chapter two will give a full description of the networks and the context in which they operate. Chapter three will discuss the issues as they pertain to the networks and their respective environments. Chapter four contains my conclusions and recommendations concerning the installation of the IS laboratory.

B. BACKGROUND

1. Laboratory Structure

The IS laboratory will consist of three networks which will be utilized for instruction and research by the IS faculty and students. The structure will also consist of a number of highly specialized workstations for computer aided design, artificial intelligence, and desktop publishing which will not be configured on a network. These are listed in Table 1.

2. Laboratory Networks

The IS laboratory is to contain three networks. They were identified in Table 1. The networks each have differing functions within the IS laboratory.

TABLE 1
IS LABORATORY EQUIPMENT

Networks	*Workstations*
IBM Token Ring	Video Presentation System
	Pagemaker Desktop Publishing
3Com Ethernet	IBM 3270 PC/G Terminals
	Document Scanner
Apple AppleTalk	Integrated Solutions, Inc. Workstation
	Symmetric, Inc. Unix Computer

a. Token Ring Network

The Token Ring network will be the primary network. Its purpose is to give the students hands on experience with the functions of a Token Ring network and the hardware required for the network to function. Secondarily, the Token Ring will serve as a host system for Information Sciences students taking courses requiring some programming, such as Pascal, Dbase III+, and basic word processing.

b. 3Com Ethernet network

The Ethernet network will serve the same purposes as the Token Ring. The exception is of course the basic differences in the networks and their relative sizes. The Ethernet will be much smaller. Its primary purpose is to demonstrate a different topology and how to integrate it with the Token Ring. By using IBM computers, it too can be used for classroom projects involving programming.

c. AppleTalk

The AppleTalk network serves the same purpose as the Ethernet network. The AppleTalk uses different computer technologies than the other two networks and will demonstrate the integration of not only different topologies, but also of fundamentally different computer systems. It can also be utilized for classroom projects involving programming.

3. Laboratory Workstations

The IS laboratory will contain workstations for graphics, desktop publishing and video presentations. Each workstation will occupy the same approximate space as an IBM personal computer. Some workstations are made up of components where each component is the size of a PC. The complete system comprises a number of components that are connected together. The workstations will be placed as space permits, the layouts will only indicate the space required for a PC sized machine and will not indicate specific workstations. During installation, the actual positioning of the workstations will be determined.

4. Administrative Sciences Laboratory

There is currently a microcomputer network already installed which is available to both Administrative and Information Sciences faculty and students. It is the Administrative Sciences Laboratory located in Ingersoll Hall, room 250.

The existing network in the Administrative Sciences (AS) Laboratory is an IBM PC-LAN. That laboratory is used for instruction by Administrative Science faculty and general usage by Administrative and Information Sciences students. Currently, there is very little network research conducted, except for thesis research.

The AS laboratory consists of 25 IBM PC/XT computers served by 4 IBM PC/AT computers on an Ethernet LAN. During the design and implementation of the AS laboratory a requirement was issued from the Dean's office which dictated there be 25 user terminals in the laboratory for the standard class of 24 students and 1 instructor. This requirement also dictated the layout of the laboratory. The room utilized contains the entire network along with three printers and some shelf space for documentation. Figure 1.1 contains a diagram of the AS laboratory.

C. NETWORK INSTALLATION ISSUES

The costs of installing the laboratory is a key issue but one which will not be addressed in this thesis. The need for the laboratory is accepted and the cost to install the laboratory is limited to the hardware costs only. Except where mentioned, additional installation costs are considered to be zero, as they involve sunk costs, or costs which have already been incurred, either directly or indirectly due to the selected location of the laboratory.

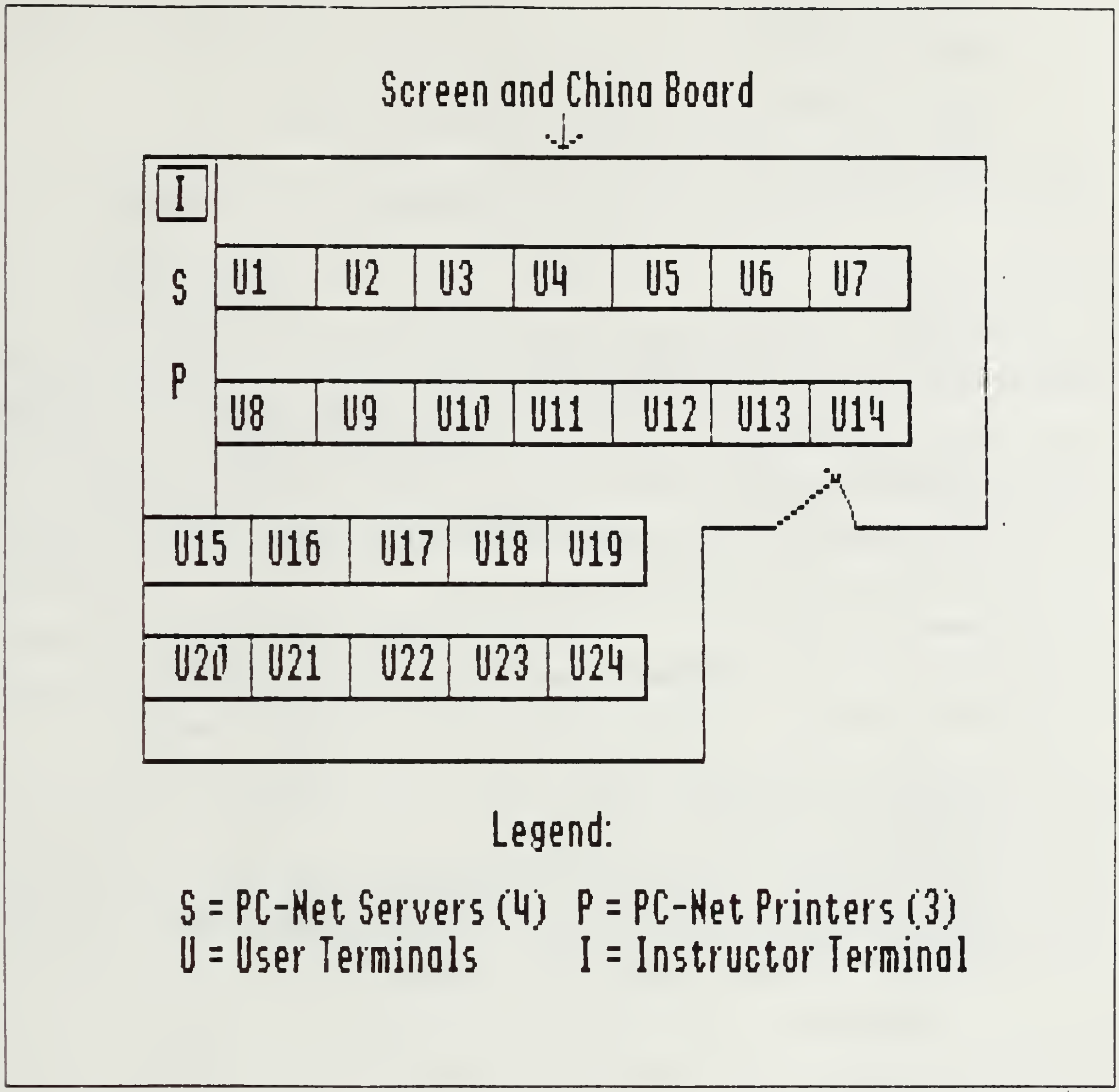

Figure 1.1 AS Laboratory floor plan.

The other key issues involved in the installation of a LAN involve cost tradeoffs, such as the cost of increasing ventilation verses the increased life of the laboratory. Of course these costs are important to the installation of the laboratory in that the LAN's have certain constraints within which they will operate properly.

The issues which are addressed specifically are the most important ones. These are:

- Power requirements
- Fire safety
- Ventilation requirements

- Software compatibility
- Growth potential
- Space limitations
- User comfort

There are also additional issues such as funding, but these will not be addressed.

D. SOLUTION

I propose a phased approach to the installation of the IS laboratory. The phasing would consist of installing a small portion of the largest LAN, the Token Ring, testing and debugging that LAN, then installing the Ethernet and AppleTalk LAN's and debugging them. As the LAN's are utilized and the users indicate their needs more accurately, they are updated to reflect those needs. Once the LAN's are established, they can be interconnected and debugged, allowing for the transfer of data from one network to the other. As a final step, expand the Token Ring to utilized the remaining space in the IS laboratory room. The workstations would be installed as they arrived and set up per instructions in the software packages utilized.

Chapter four explains this approach and more thoroughly addresses the above problems with solutions to them.

Appendix A contains some possible layouts for the introduction of each of the LAN's to the IS laboratory. There are also layouts for the workstations. The author's preferred layouts are indicated in chapter four.

II. FUNCTIONAL DESCRIPTIONS

A. INTRODUCTION

This chapter will identify the laboratory and the networks to be installed in it. First, there will be a description of the laboratory, identifying the purpose of the laboratory and then the hardware that will constitute the laboratory.

The next section will fully describe the networks, both logically and physically. A description of the networks will aid the reader in understanding the purpose of the laboratory.

B. THE INFORMATION SYSTEMS LABORATORY

1. Purpose

The purpose as stated in the mission element need statement is, "To demonstrate the various methods and benefits of distributed computing, the relative merits of various networking topologies, and to be able to experiment with the various applications that are presented in the classroom. The laboratory would also act as a test bed for thesis research in the information science curriculum." [Ref. 1]

To clarify, the purpose of the laboratory is to give the students the hands on experience needed to fully understand the operation of networks relative to their topologies. Classroom instruction without the aid of the hardware does not give students a full appreciation of the operation of a network.

The laboratory facility will also give students the knowledge of the difficulties of communicating between networks. Not only ones with similar topologies, but also of differing topologies. This will be accomplished by placing different networks in the laboratory.

The facility will also be available for thesis research involving networking systems.

The Administrative laboratory will be available to help meet the objectives of the IS laboratory. The AS laboratory cannot meet the objectives of the IS laboratory alone because it contains only the one network, the PC-LAN network. The AS laboratory will eventually be connected to the IS laboratory, increasing the number of interconnected networks to 4.

2. Hardware

The IS laboratory will consist of a number of IBM PC/XT's and PC/AT's connected to no more than four IBM PC/AT server computers. The XT's and AT's will be the user terminals accessing programs and information on the server terminals. They will be connected via the IBM Token Ring Network hardware to form a token ring network.

Also contained in the laboratory will be five Apple Macintosh Plus computers connected together via the AppleTalk Ethernet network hardware. Data and programs can be shared among the Macintosh computers equally.

A 3Com Ethernet network consisting of 6 IBM PC/XT computers and one file server will be connected together via the 3Com Ethernet hardware. The connection will form an Ethernet bus network.

In addition to the networks there will also be a number of printers to support each network, including a laserprinter attached to the AppleTalk network. The laboratory will also include a number of specialized workstations for Video Presentations, Desktop Publishing, Computer Aided Design (CAD), 3270 PC workstations for use with the NPS IBM 3033 mainframe computer, and other PC sized workstations.

3. Environment

The IS laboratory will utilize an existing classroom and laboratory facility. The classroom will be room 224, Ingersoll Hall, and the laboratory space in room 158, Ingersoll Hall will also be used. It is desired that the networks be placed in close proximity of each other and the special workstations be placed where space permits.

The primary concern is the space limitations dictated by the need to utilize all classrooms for classroom instruction. Therefore only the one classroom is available for the laboratory. This is the only major constraint placed on the laboratory.

C. THE NETWORKS

1. IBM Token Ring

a. Logical Description

The IBM Token Ring is IBM's implementation of the theoretical token ring topology of a network. The topology of a network refers to its appearance, as in a ring, tree or bus. The token ring describes the topology of the network as a ring which passes a token from one node to the next, allowing each node to control the network while it possesses the token. Figure 2.1 [Ref. 2: p. 148] is a diagram of the ring topology.

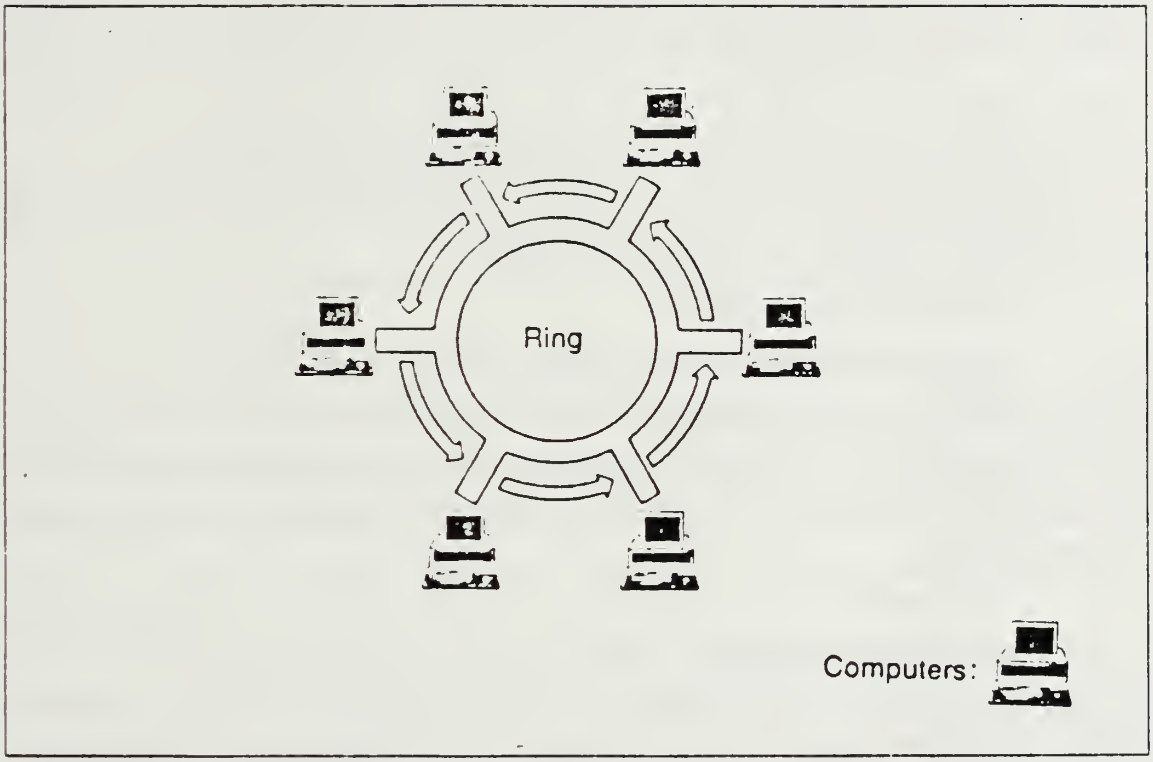

Figure 2.1 Ring Topology.

A ring network consists of a number of special interface devices each connected to exactly two others by a communications link so that together a circular data path is established. The common distinction between a ring network and a loop network, which is similarly configured, is based on the control strategy employed. Loops are considered to have centralized control, as in a polling loop, while the control of a ring is distributed with each of the interfaces participating in the control strategy. [Ref. 3]

The ring interface is an active element in the transmission system through which all messages must flow. All ring interfaces must contain the capability to recognize addresses on messages traveling around the ring, to copy off messages addressed to the subscriber device it supports, and to mark in some way messages that have been so copied. [Ref. 3]

An indepth study of token passing is beyond the scope of this thesis; suffice it to say that as each node (terminal) of the network receives the token, that node is allowed to perform a network function such as messaging another node or executing a program that is contained on the server node. At the completion of each network function, the token is passed on to the next node in the ring, allowing it to execute a network function. This passing of tokens is carried out very rapidly, so there is very little waiting by the user if he/she wishes to execute a network function. Only on very large implementations of a token ring does the user experience a delay, and then only when there are many users at work for each server.

b. Physical implementation

IBM implemented the token ring by means of an interface card in a slot which is connected to the ring junction box via a coaxial cable. The interface card acts as the ring interface, responsible for copying those messages addressed to its PC and passing on those that are not. It also places addresses on messages that originate from its connected PC.

The junction box has connected to it the remainder of the rings PC's, or another junction box if the quantity of PC's is great enough. This junction box is the ring in which the token is being passed. It serves as a logical ring and also serves the added feature of enabling the ring to function if a node is down. In the logical ring, if a node is down, the ring is no longer a ring and therefore cannot function. The token will not be passed on.

To the junction box is also connected the server computers which contain the programs and other files the users may need as they are attached to the network.

2. 3Com Ethernet

a. Logical Description

The 3Com Ethernet is 3Com's version of the Ethernet local area network. The Ethernet was first introduced by Xerox Corporation's Palo Alto Research Center. It is based on the ALOHA network developed at the University of Hawaii.

The idea of the ALOHA network is a contention scheme where transmission from a terminal is allowed at any time. After transmitting a packet, or block of data, the terminal waits a set time interval for an acknowledgement. If no acknowledgement is received, the packet is retransmitted. The receiving terminal determines the validity of the incoming packets based on checksums carried with the packet. Valid packets are immediately acknowledged, invalid packets are ignored. [Ref. 3]

The Ethernet introduces an additional capability to the network which is carrier sense multiple access or CSMA protocol. In this method terminals listen to the network and if a carrier is sensed, they are allowed to transmit their packets. This enables the network to operate at a higher rate by giving all terminals equal access to the network at all times.

The 3Com version adds another refinement which is the method of collision detection of transmitted packets. It uses a collision detection scheme where the terminal transmits the packet and then listens to the carrier. If a collision with another terminal's packet is detected, transmission is halted and the carrier is jammed for a length of time. This clears the carrier and after a random wait, the packet is retransmitted.

The topology of the 3Com network is a bus network. On a bus network, the data path of the connected devices is shared by all devices therefore only one transmission is allowed at a time. Figure 2.2 [Ref. 2: p. 148] is a diagram of a bus topology. It is a baseband system, utilizing digital signaling. Digital signals are inserted on the transmission line as a voltage pulse representing a 1 or a 0. Essentially a packet is transmitted into the "ether" of the transmission medium and while all terminals can receive the packet, only the one addressed by the packet actually does.

b. Physical Implementation

The 3Com network requires an interface card in each terminal that is interconnected with the other terminals via a coaxial cable which acts as the bus. The

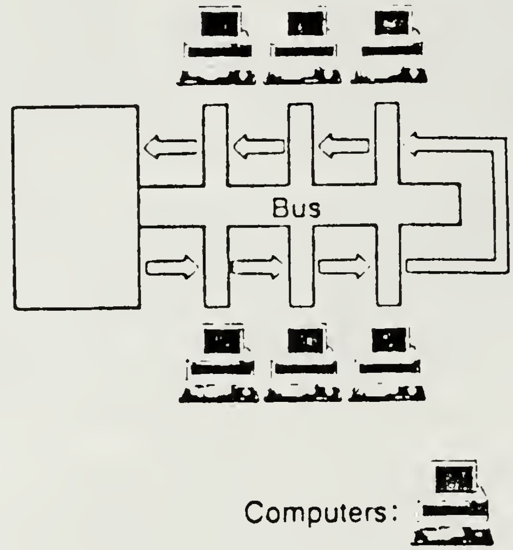

Figure 2.2 Bus Topology.

interface card contains a modem and serial/parallel converter which takes the parallel data of the terminal and converts it to serial format for transmission via the modem. The file server contains files which are shared by the terminals.

3. AppleTalk Ethernet

a. Logical Description

The AppleTalk network is also an Ethernet local area network utilizing the CSMA protocol described above under the 3Com network. The major difference is the refinement of the protocol. AppleTalk uses collision avoidance as its method of handling the collisions. In collision avoidance the terminals transmit their packets based on a time slot, and if a collision occurs, those terminals involved in the collision are allowed to transmit next.

The time slot is a window in which the terminal is allowed to transmit if a packet is ready for transmission. Picture the dial of a watch. With three terminals the window size could be twenty seconds for each terminal. Terminal 1 would have a window from 0-19 seconds, terminal 2 would have 20-39 and terminal 3 would have

40-59. Each terminal would wait 40 seconds before its window would be open for transmission again.

Using this method the probability of a collision is very small. Of course the window size would be measured in milliseconds or microseconds and the wait would likewise be measured in smaller units. Collisions might occur if the transmission began late enough in the window that another terminal's window opened and it transmitted prior to the completion of the first terminal's transmission.

b. Physical Implementation

The AppleTalk network uses an interface card in the terminal and is connected to the other terminals via shielded cables configured as a bus topology. In the Macintosh Plus computer, the interface card is built into the motherboard, simplifying installation to the point of merely installing the cabling and configuring the virtual slot for AppleTalk.

D. SUMMARY

The reader should now have a reasonable understanding of the different technologies involved with the three LAN's and their importance to meeting the objectives of the IS laboratory. The next chapter will address some installation issues as they pertain to the construction of a computer room.

III. INSTALLATION ISSUES

A. INTRODUCTION

This chapter will identify some issues which are faced during the installation of any computer facility. The author will also comment on the issues as they pertain to the installation of the IS laboratory.

B. PLANNING THE SYSTEM

Prior to the installation of a computer system there are a number of issues the IS manager must address. The most important is that of working with other departments, and achieving the collaboration of a number of different parties. No matter what the size of the room or the budget, no facility construction, expansion or system installation will succeed without careful planning. Managing the people and resources involved in the installation is the key to success. [Ref. 4: p. 58]

A team of experts can be assembled to ensure the smooth installation of a system, however the IS laboratory is a small enough project to enable the department head to pare the team to a much smaller, more efficient one. Most computer system installation teams include a project manager responsible to the IS manager. Working for the project manager is a group of experts which may include an electrical engineer, a mechanical engineer, a security specialist, an interior designer/architect, a lighting consultant, and an acoustical consultant. There may also be someone who knows and understands the local building codes; someone who knows the fire code and a telecommunications expert. The latter three specialties could be a collateral duty of one of the experts mentioned earlier. [Ref. 4: p. 58]

Usually the team of experts is taken from the staff of the company. In the case of the IS laboratory, the team consists of a number of professors who are well qualified to install personal computers in a room. There are no structural modifications to the room and the electrical engineering expert works for Public Works. Public Works also is staffed with experts on the building codes. Sound is not a problem because the personal computers are not inherently noisy. Because the room to be utilized is a classroom, lighting is sufficient.

The fire codes were a problem during the installation of the AS laboratory. The door opened the wrong way, not allowing the students a proper exit from the room. The solution was to install a door which opened into the hallway in a direction which did not hamper personnel traversing the hallways.

C. SPECIFIC ISSUES TO BE ADDRESSED

Table 2 contains the issues that will be expanded upon below. Essentially, there are a number of issues which must be addressed during the planning of a computer system which involves a large investment of money and/or utilizes much state-of-the-art technology. The IS laboratory is a facility which will be using IBM's Token Ring network. While the token ring is not a new idea, the physical implementation is only a few years old. There are only a few implementations in business and academia. Additionally, the IS laboratory will contain two other networks that are not new and are well established in business and industry.

TABLE 2
INSTALLATION ISSUES

Power requirements
Fire safety
Ventilation requirements
Software compatibility
Growth potential
Space limitations
User comfort

1. Power Requirements

Discovering that there is not enough power after the room is selected could be a disaster. Bringing in additional electricity is costly; it may mean purchasing and installing new power lines, transformers, and switch gears. Other electrical requirements that must be looked at are lighting, air conditioning, heat, convenience outlets, and future growth. Once power is considered adequate, there are other factors to address. The power must be free of potentially dangerous spikes that can cause power surges in the equipment. Power surges could damage data or worse destroy hardware. [Ref. 4: p. 58]

The current thinking on computer rooms utilizes a raised floor. They usually range in height from one to two feet depending on the vendor supplying the computer. The purpose of the raised floor is to get power cables, telecommunications lines, and other items out of the way. At the same time the raised floor is used to support heavy computer equipment. The space below can be used for air circulation, aiding in the cooling of the system.

a. Power for the IS Laboratory

The rooms selected for the laboratory have sufficient supply of power to run the three networks simultaneously. Because the requirements were stringent during the construction of the building and the power delivered to the Postgraduate school is needed to power a myriad of electronic equipment, the power is clean enough for the personal computers to be used in the laboratory.

The layouts for the IS laboratory consider power distribution. The networks will all be located such that sufficient outlets will be available without the need for contractor support. The Token Ring will require some extension cables with line surge suppressers to ensure safe, clean power to the remote terminals. The wiring can either be located in a conduit, as in the AS laboratory, or simply bundled and secured to the front of the tables using nylon straps. The straps allow full access to the cables but keep them secured and out of possible danger from students.

The ventilation system is on a different power system and is therefore not affected by the laboratory installation. Lighting is sufficient and the convenience outlets already existing in the room should provide adequate for future needs. Any additional outlets required by the networks will be installed.

Because the laboratory consists of personal computers, there is no requirement for a raised floor for aiding in ventilation. However, a raised floor may be useful for housing the Token Ring junction boxes and the cabling that the Token Ring network requires. Phone lines and power cables could also be housed there.

2. Fire Protection/Safety

Fire protection can range from hi-tech fire detection equipment with halon extinguishers to low cost hand held ones. A prevailing misconception is that water can be harmful to electronic equipment. Water is dangerous if the equipment is energized. That could contribute to the fire by shorting and burning the circuits.

Once power is secured to the equipment water can be safely used to extinguish a fire and if the equipment is thoroughly dried before it is used, there should not be any damage. Current methods of cleaning salt water from electronic equipment at sea is to immerse it in clean distilled water to flush out the sea water. The equipment is then placed in ovens to quickly dry the water to prevent corrosion of the metals in the equipment.

Unfortunately, time is lost while the equipment is out of service and in cleaning drying. This can sometimes take as long as a few weeks depending on how much water was used and the equipment involved. The alternative to using sprinklers in the computer room is halon gas. Halon gas is exhausted into the room, quickly displacing all oxygen and choking the fire. Cleanup is accomplished by ventilating the room fully.

The IS laboratory is not extensive enough to warrant the high cost halon gas system. Most fires that originate in the laboratory will be put out via carbon dioxide extinguishers. By the time water is brought in on the fire, the laboratory will have been at least partially destroyed.

An issue in the installation of the AS laboratory was the ability of the users to exit the room rapidly during a fire. The desks were placed such that the door blocked a safe exit by two-thirds of the users who had to close the door to get from behind the row of desks. The solution seemed to be simple: Have the door open outward. Unfortunately that meant the door would open into the hallway, potentially blocking personnel who were attempting to exit the building. Eventually the fire marshall allowed a door which opened into a corner of the hallway which would not impede exiting traffic in any way.

3. Ventilation Requirements

As indicated earlier, the ventilation system used by the computer room must have proper power to maintain the ventilation needs of the computer room. Most computer systems today require some cooling to ensure their maximum efficiency. While the IS laboratory is not a mainframe requiring water jackets to ensure proper cooling, there are a number of personal computers that are to be placed in a single room. Couple this with the person's body heat who will be seated at each terminal and there could be a potentially warm situation. The personal computers will all have their own internal cooling fans to aid in keeping them cool, but the users may not remain cool.

4. Software Compatibility

When installing a local area network there is the possiblity that some of the software installed on the network will not function properly. Most software requires an installation procedure that configures the software to its operating environment. Once installed the software vendors may require that the startup or boot disk remain in drive A while the system is running. This is not acceptable on a network. The software and information must be accessable and usable to all users that have access to the network.

In the case of the IS laboratory, the Token Ring uses the same operating system as the AS laboratory: PC-LAN. Therefore if the software is compatible with the AS laboratory, it should also be compatible with the Token Ring. Major software developers include a network capability within the software they produce or they are developing that capability. This ensures the software will operate properly within a network environment. All software written by Apple is compatible with the AppleTalk LAN.

5. Growth Potential

During the installation of a computer system it is always safe to include the possibility of growth in the future. The current system is never enough and the future system will eventually fall short of the needs of the users.

The IS laboratory consists of three LAN's and other workstations. The AppleTalk LAN is limited only by the space available. The computers can be chained together up to a limit of 32 terminals [Ref. 5: p. 164]. The 3Com LAN is similar.

6. Space Limitations and User Comfort

The most important aspect of the planning of the IS laboratory is the space limitations imposed by the rooms selected for the installation. Due to the small size of the room and the purpose of the laboratory, the growth potential is not a very important issue. It would be almost impossible to put more than 30 personal computers in room 224.

While planning for the three networks, or more precisely finding room for them, the comfort of the users must be kept in mind. There must be enough room for the users to comfortably work at the terminals and to move about the room accessing documentation or the printers. The height of the monitors is key to ensure an adequate view of the instructor during classroom sessions.

D. SUMMARY

While there are possibly more issues involved in the planning and installation of a computer room, those addressed above are the most important. They are the ones which will make or break the installation depending on how they are solved. The next chapter will specifically explain how the space limitation issue was solved.

IV. LABORATORY SOLUTION

A. INTRODUCTION

This chapter discusses the proposed layouts for the IS laboratory. The laboratory will comprise the two rooms, 158 and 224 of Ingersoll Hall, and incorporate all hardware necessary to meet the objectives of the laboratory. The solutions discussed here are limited to the layout of the laboratory, all other aspects of the laboratory have been recognized and if a problem existed, it was dealt with.

Appendix A contains the layouts that will be discussed in this chapter. Each layout will be referenced by its figure number in the appendix.

The author will attempt to describe in detail the justification or other explanations necessary for the reader to fully understand the layouts. There is, of course, a preferred layout. These layouts are identified below.

B. SPACE LIMITATIONS

As stated above this thesis is limited to addressing the layout of the IS laboratory. The primary constraint excepting money is space. The only rooms available for the installation of the laboratory were two rooms not already being utilized as classrooms. These rooms together supply sufficient space for the laboratory, but because they are separate, the laboratory must also be separate.

1. Network Size

One objective of the IS laboratory is to instruct students in the operation of networks and the cooperation of different networks. The author feels that the best method of meeting that objective is to have the networks which must cooperate in close proximity. This allows the students the ability to immediately observe the networks and the inter-communication that is taking place. Unfortunately, due to the small size of the available rooms, only small networks can be placed in a room.

The primary network is the Token Ring. Due to the proliferation of software available to NPS for the IBM PC, it is the network which will be utilized most by students. The IBM PC is also the standard personal computer utilized by the Navy and therefore is the one most familiar to the students at NPS.

2. Class Size

Class size in the Information Sciences curriculum is normally 24 students. Classes are usually scheduled in two two hour blocks or four one hour blocks each week. Most classes do not have regularly scheduled laboratory meetings but instead the instructor will schedule a class period as a laboratory.

The author's experience with laboratories is that a laboratory class of no more that twelve students is best when the instructor must give some individual attention to students. Some students are somewhat knowledgeable about a personal computer. Those students tend to pick up the operations of new computers and their operating environment rather quickly, whether the environment is a stand alone system or on a network. Some students are at the other end of the spectrum and require a very slow paced walk through the operating system and the commands required to operate the machine.

A class size of 24 students may have twenty percent at each end and the remaining somewhere in the middle of the learning spectrum. That equates to four or five students with the where-with-all to operate a system with little or no help from the instructor and another four of five that require the instructor's complete attention.

3. Recommended Class and Network Sizes

What this is leading up to is that the instructor can easily work with a class that is half the size, or only twelve students, when in the laboratory. This allows the instructor to work with the students much more closely than in a larger class size of 24 students. There is more individual attention given the students and the instructor is able to concentrate more on the brunt of the topic.

The reader may question this approach with the argument that it doubles the amount of time the instructor must spend in the laboratory. The author's experience has been that when the entire class is present, three to four hours are required to fully receive the instructor's lesson instead of the one or two that could have been used. For a class which meets for two days a week, two hours each day, the first hour can be spent in the laboratory and the second utilized when the student is best able to work in the laboratory on his/her own, without the instructor. Thus, the instructor can conduct a lesson with half the class present the first hour and the other half the second hour. This gives the students more time with the instructor and gives the instructor less to manage.

C. ROOM 224

1. Network Installations

a. Token Ring

Figure A.1 is the floor plan which contains the Token Ring network. It shows only 13 user terminals (marked U) supported by two server terminals (marked S) and two printers (marked P). The printers could be placed in a stackable unit such that the printer connected to a server is located directly over the server. This would allow at least one more user terminal but not more than two additional terminals. The students each will be using the user terminals and the instructor will use the terminal marked I. The instructor terminal may or may not be placed on a movable stand, allowing the instructor to move his terminal to face the students comfortably. The use of only four users in the front row facilitates movement about the three networks. If required, another user terminal can be placed on the front row.

Figure A.2 is a similar floor plan but instead utilizes PC hanger hardware. The PC hanger places the cpu in a vertical position on the side of the desk. This gives the student more desktop space to work with. But requires six more inches of floor space for the additional length. The author feels the desks are large enough for both the cpu and paper for taking notes. Using PC hangers simply gives the student a location to store his/her books during class. Not utilizing the hangers gives the students more space to move about in the laboratory. The area marked storage can be utilized for books.

b. Ethernet

The Ethernet LAN is small and requires only enough space for the maximum of five users to sit comfortably. The user terminals are indicated in Figures A.1 and A.2. During a classroom session, these terminals will not normally be active and therefore will not interfere with the Token Ring students. A total of six terminals will be placed on four tables in addition to the file server. This will be a crowded network, however an additional table can be added, but it may then interfere with the AppleTalk network.

c. AppleTalk

The AppleTalk LAN is the smallest of the networks to be installed. It requires only four tables for the five terminals. It should be placed as indicated in Figures A.1 and A.2 for the same reasons as the Ethernet LAN. It can be switched with the storage area to allow more space for the Ethernet LAN if necessary.

2. Workstations

The workstations will not be installed in room 224. With three networks and the hardware required to support them there is insufficient space to comfortably work with the special workstations.

3. Other Hardware Installation

Other items of hardware that must be installed are a china board, projection screen for the instructor's terminal, and storage shelves for documentation and paper. It is recommended that the screen be placed above the Ethernet LAN. This places it in front of the students and will not interfere with the other networks. The china board should be placed as indicated in Figures A.1 and A.2. It is easily accessed by the instructor and viewing will not be difficult for the students.

Below the recommended location for the china board is a space which can be utilized for storage of printer paper and other items. The space can be locked if a secure place is required for storage. Shelves should be mounted above the AppleTalk LAN for documentation for the LAN's and their installed software. Figure A.3 is an alternative solution for the AppleTalk and Ethernet LAN's.

D. ROOM 158

1. Network Installation

The only network which should be placed in this room is another small Token Ring with its server and printer. It can be placed as shown in either Figures A.4 or A.5. The Token Ring is indicated by the "T". The server unit can be any one of the units. In both figures, the light line indicates where a shelf could go to increase available space. In Figure A.4 this shelf would be used to support additional Token Ring terminals and their printer. The use of monitor stands for the users who would stand at these terminals would ease the strain of reaching over the users seated at the terminals below. Of course, the less used items would be places on the upper shelf such as server computer and printer.

Placement of monitor stands should be such that the users are staggered, one seated then one standing, and so on. The use of the monitor stands in Figure A.5 would be at a minimum, there being all Token Ring terminals at the lower levels. The printer would be placed at the upper level.

2. Workstation Installation

Figures A.4 and A.5 also indicate the location of the workstation components. They are marked "W". Each component is the same approximate size of a personal computer. While some workstations only require one component, others require as many as four. These can be placed as indicated in the two figures.

The light lines again indicate shelves which can be utilized for more workstations and the use of a corresponding monitor stand, printers and other equipment used by the workstations.

3. Other Hardware Installation

Other items to be installed include a document reader and slide maker. These should be placed on shelves, if used, above the workstations. The areas marked "S" already exist and can be opened for use, although not for secure storage.

E. RECOMMENDATIONS

1. Room 224

Figure A.1 is the author's preferred layout for this room. It utilized a large Token Ring network and fully facilitates the other two. The networks are "centered" in the front of the class, drawing attention to the different networks used. There is more space for a group to stand behind the group utilizing the 3Com or Apple networks. And there is ample storage space.

2. Room 158

There are no alternative layouts for this room. The author feels that utilization of a terminal while standing is fine, however the use may get bothersome when another user is directly below and in front of the standing user. Staggering may help, but there is a potential for problems. The shelving should be utilized, but use of the upper level for actual work should be kept to a minimum. Limit the second level user to minor tasks such as input and output.

Alternatives for this room are the placement of the Token Ring. The author feels it should be placed in the outer room. If the upper level is limited to two users and the server and printer, it should ensure little confrontation between users.

F. SUMMARY

The floor plans presented in this chapter and in the appendices were constructed with the student in mind. It is the students who will utilize the laboratory most, they will be using the terminals for thesis research including the typing of their theses. The Token Ring network was located to ensure the students have a clear view of the instructor and his her projection screen. In addition, the students should be able to see the china board when it is used.

Because the Ethernet and AppleTalk networks are small, the instructor should not need to face the students while teaching them the use of those networks. Therefore they were placed facing the walls to increase the utilization of the available space. The instructor can simply stand over their shoulders and aid the students as they need it.

While it is recognized that not all recommendations made in this thesis will be utilized, the issues raised should give the reader some insite into the problems of installing a computer system.

APPENDIX A
ALTERNATE SOLUTIONS

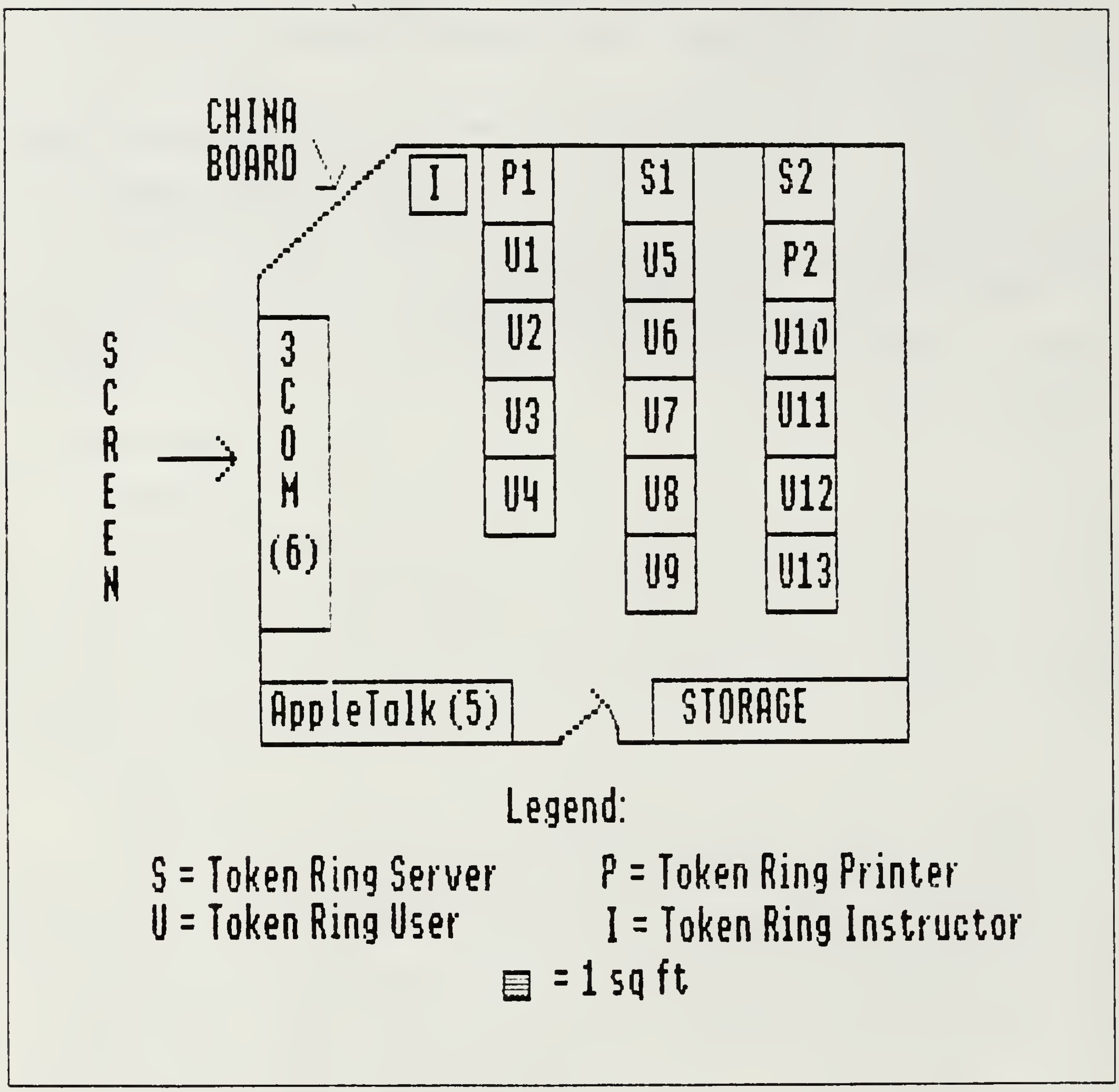

Figure A.1 Alternate Layout for room 224.

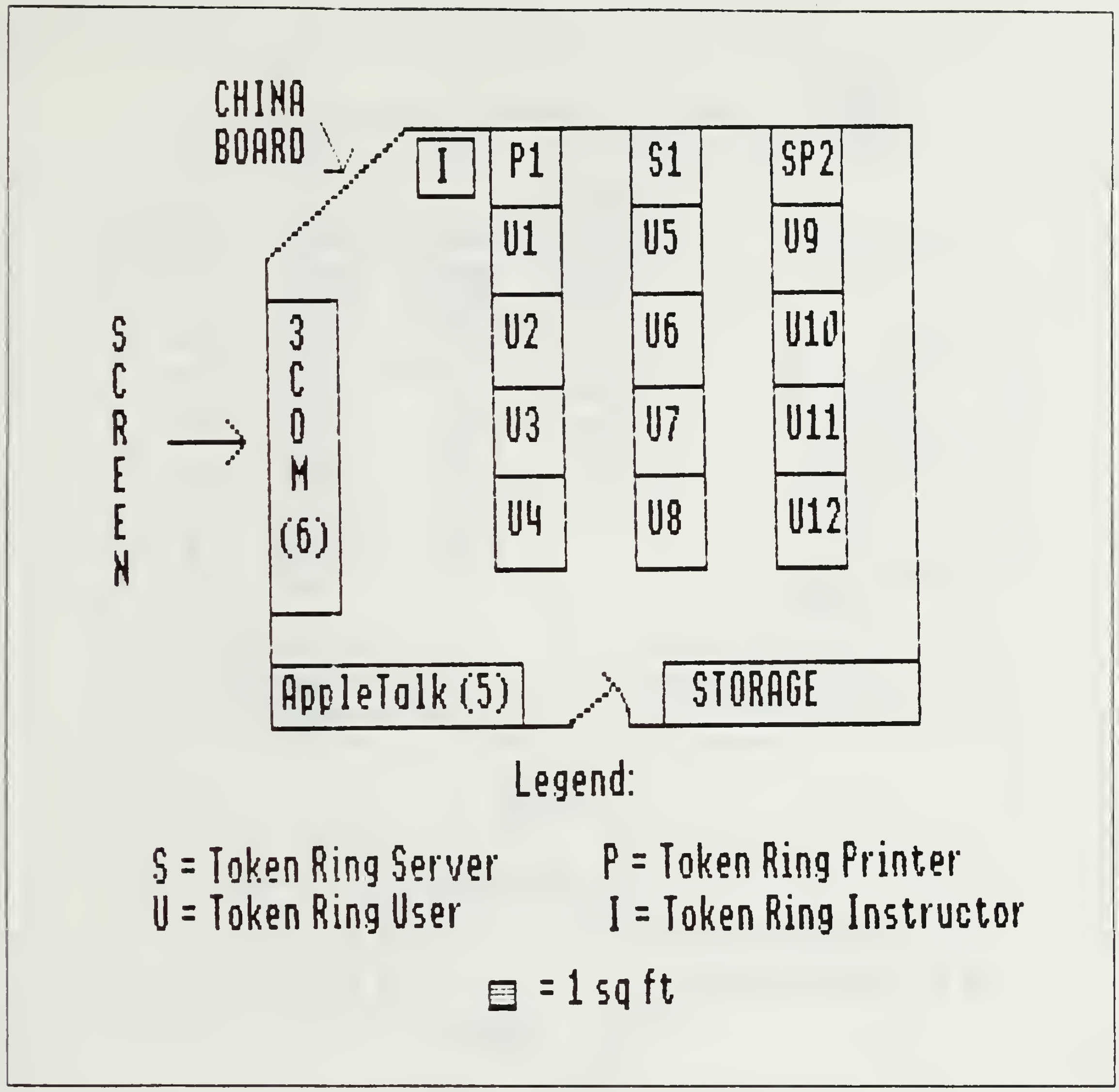

Figure A.2 Alternate Layout using PC hangers.

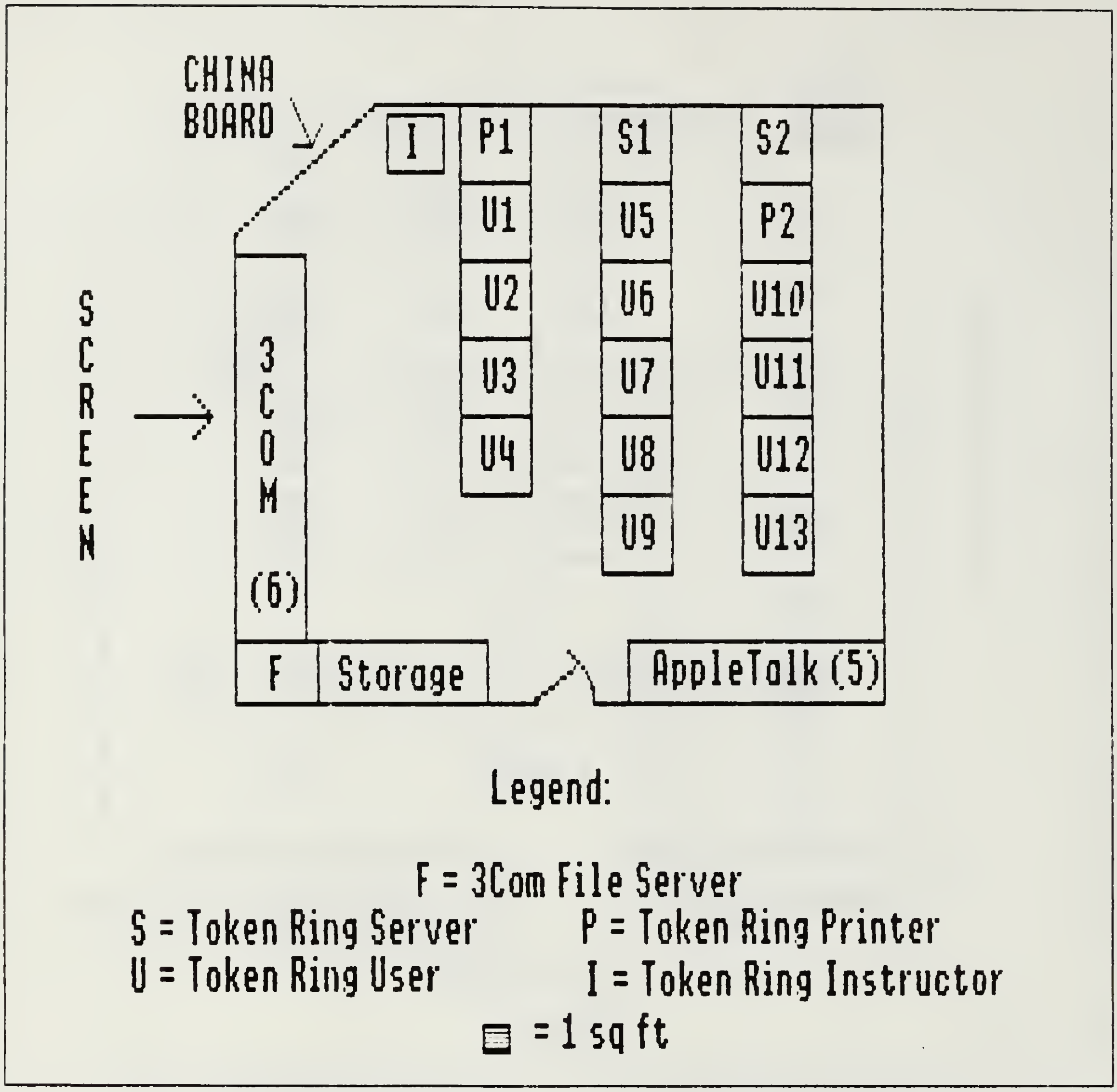

Figure A.3 Alternate Layout for room 224.

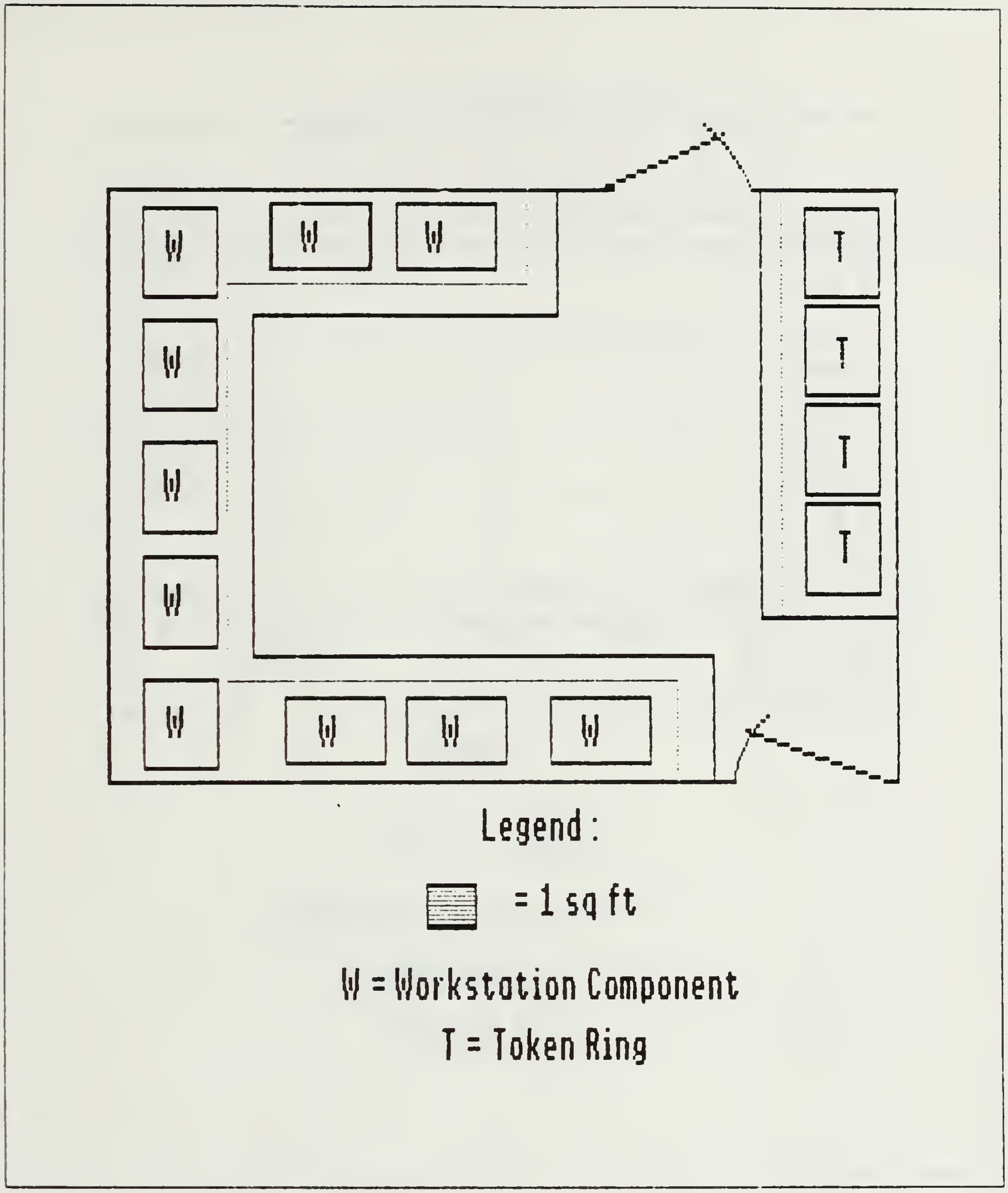

Figure A.4 Layout for room 158 (outer).

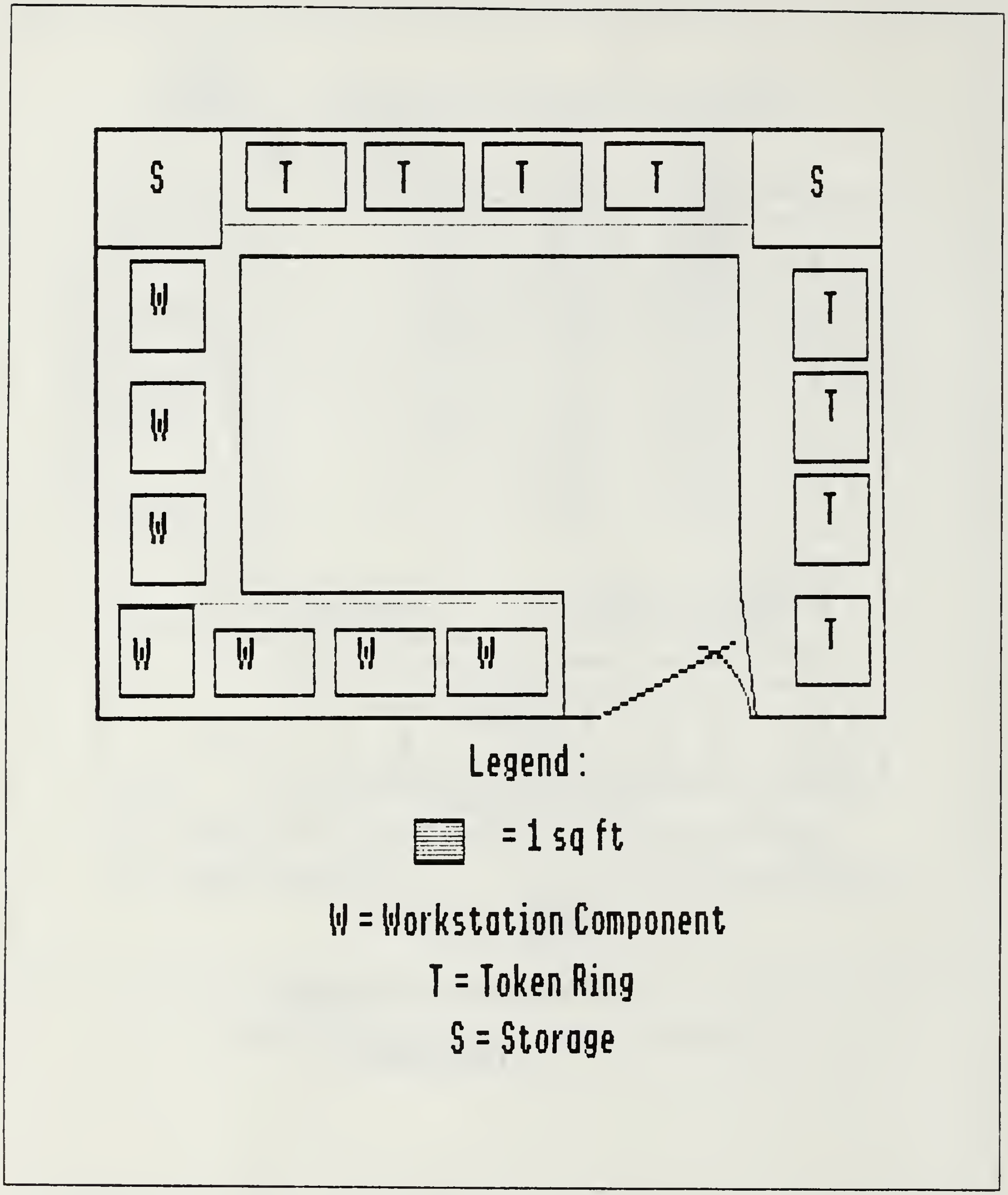

Figure A.5 Layout for room 158 (inner).

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